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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/813,240	03/20/2001	Wilfried Von Ammon	VON AMMON ET AL 9	1729

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EXAMINER	
MONDT, JOHANNES P	

ART UNIT	PAPER NUMBER
2826	

DATE MAILED: 11/20/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/813,240	AMMON ET AL.	
	Examiner	Art Unit	
	Johannes P Mondt	2826	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondenc address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *18 August 2003*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *2 and 4-6* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *2 and 4-6* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Response to Arguments

1. Applicant's arguments, see Response filed 8/18/2003, with respect to the rejections of claims 2 and 4-6 under 35 U.S.C. 103(a) have been fully considered and are persuasive. Therefore, the rejection has been withdrawn. However, upon further consideration, a new ground of rejection is made in view of Ikari et al (Japanese Patent Application 2000-026196, published January 25, 2000) and Yamamoto et al (6,123,909), and in view of Holder et al in view of Ikari et al, with regard to independent claim 2, with supplementary references for dependent claims. In response to the comment by Applicant that "Kim fails to teach or suggest the invention", it is respectfully pointed out that the examiner never said Kim does; Kim is only used once again to teach the heat shield as claimed in claim 4.

Claim Rejections - 35 USC § 112

2. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

3. ***Claim 5*** is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim contains subject matter not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. In particular, Applicants do not disclose how to achieve an atmosphere containing less than 3%

hydrogen in volume percentage and the balance being argon. As is well known in the art, argon gas contains contaminants of a variety of gases, even in so-called ultra-high purity form, as for instance disclosed in the purity info release by "Air Products" (cf. PTO-892), cannot be avoided to contain inter alia carbon monoxide, carbon dioxide, nitrogen, oxygen, in addition to hydrogen. Therefore, without specific showing how said mixture of hydrogen and argon as claimed is produced, the Specification by Applicants does not enable claim 5.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

5. ***Claims 2 and 5*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Ikari et al (WO99/57344) in view of Yamamoto et al (6,123,909). Ikari et al (WO99/57344) is available in English through its National Stage, Ikari et al (6,548,886 B1), which will be cited in the sequel. Upon request of Applicant a translation of WO99/57344) will be made available. *Ikari et al teach* a method for producing a silicon semiconductor wafer (cf. title) comprising:

pulling a silicon wafer from a melt using the Czochralski method (cf. abstract and col. 10, l. 58 – col. 11, l. 11), wherein the silicon single crystal is pulled under an atmosphere of argon comprising gas (cf. col. 10, l. 58-col. 11, l. 11);

doping the silicon single crystal with nitrogen and producing a nitrogen concentration of not less than 10^{16} atoms/cm^3 and not more than 1.5 x 10^{19} atoms/cm^3 (cf. abstract, first sentence); and

separating the silicon semiconductor wafer from the silicon single crystal, which is inherent in any method to "obtain" said silicon semiconductor wafer from a silicon single crystal grown by the Czochralski method.

Ikari et al do not necessarily teach the further limitation that said pulling must take place in an atmosphere that has a hydrogen partial pressure of less than 3 mbar. However, for reasons of economy related to the relatively high price of argon (argon is used by Ikari et al, cf. col. 10, l. 58 – col. 11, l. 11) it would have been obvious to employ an argon purification process for the recovery of argon employed in the Czochralski process as taught by Yamamoto et al, who, within the context of the purification of argon gas used in a Czochralski pulling apparatus for manufacturing single crystal wafers of silicon (hence analogous art; cf. col. 1, l. 1-29) teach the addition of hydrogen gas to remove oxygen (cf. col. 4, l. 46-62) in a process leading to high purity argon gas in which the concentration of hydrogen is 1 PPM (part-per-million) or less after most of the hydrogen is removed as well. Because of Dalton's law the partial pressure of hydrogen gas in the high-purity argon gas to be re-used for the Czochralski process is 10^{-6} or less times the total pressure of the high-purity argon gas, which in view of the gas pressure in the furnace being between 20 and 60 Torr (1 Torr = 1333.2 μbar) implies a partial hydrogen pressure between 2.67 and 8.00 % of one (1) mbar, which is in the range claimed. Motivation stems from (a) the undesirability of oxygen in the argon

gas as oxygen causes defects (cf. Ikari et al, col. 11, l. 51-55), (b) the successful recovery of the relatively expensive argon gas used by Ikeda et al in a state in which the oxygen content is extremely low (< 1PPM) (cf. col. 7, l. 45-48 in Yamamoto et al). Combination of the teaching by Yamamoto et al with the invention by Ikari et al is easily accomplished because the purification process by Yamamoto et al is specifically aimed at being combined with the Czochralski process of producing single crystal silicon.

On claim 5: Ikari et al in combination with Yamamoto et al teach subjecting the semiconductor wafer to a heat treatment in an atmosphere which contains argon with a purity such that hydrogen is present at 1 part-per-million (cf. Yamamoto et al, col. 7, l. 45-48) in a high-purity argon gas with only minor traces of nitrogen, carbon dioxide, oxide and methane left. With reference to the rejection under 35 U.S.C. 112, first paragraph, of claim 5 as provided above, the high-purity argon gas in which hydrogen has been deliberately added in order to enhance to overall purity is the closest one could achieve to the non-enabled mixture claimed here.

6. ***Claim 4*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Ikari et al and Yamamoto et al as applied to claim 2 above, and further in view of Kim (5,942,032), made of record before. As detailed above, claim 2 is unpatentable over Ikari et al in view of Yamamoto. Neither Ikari et al nor Yamamoto et al necessarily teach the further limitation as defined in the present claim 4.

However, the use of a heat shield in the context of the Czochralski method for selectively shielding a semiconductor single crystal ingot is widely known in the art; see

Kim et al (cf. abstract and claim 1 starting at column 10), which is closely related art, namely: the control of the composition of, - and the suppression of, the agglomeration of crystal defects (cf. col. 1, l. 6-20) within the context of a silicon single crystal grown using the Czochralski method. The purpose of the use of the aforementioned heat shield, namely the selective shielding of the monocrystalline ingot to control the type and number density of agglomerated defects in the crystal structure (cf. Kim, cf. abstract, first sentence) is fully relevant to the invention taught by Ikari et al that aims at a reduction of the number of COP defects (cf. col. 6, l. 6-37); therefore, there exists ample *motivation* to combine the inventions. It is indeed possible to *combine* the inventions because the addition of a heat shield does not interfere with any of the requirements in the invention taught by Ikari et al. *Expectation of success is reasonable* in view of the success of the use of heat shields in the context of the Czochralski method as shown by Kim et al.

Finally, Ikari et al cool the single silicon crystal in the CZ furnace from the solidifying point T_m (known to be about 1414 degrees Celsius; cf. CRC Handbook of Chemistry and Physics, 82nd Edition) to 800 degrees (centigrade) at the rate of not less than –2 degrees centigrade per minute (cf. claim 21, col. 58), hence in particular cool the said single silicon crystal a forteriori from 1050 degrees to 900 degrees Celsius in no more than 75 minutes, a forteriori in no more than 120 minutes.

7. ***Claim 2*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Holder et al (6,039,801) in view of the published PCT Application by Ikari et al (WO99/57344) and

Tamatsuka et al (6,191,009 B1). As in the rejection above, Ikari et al (6,548,886 B1), being the National Stage of said PCT is used as an English translation in the following discussion. Upon request by Applicants a translation of the PCT will be made available.

Holder et al teach:

pulling a silicon single crystal from a melt in the presence of argon using the Czochralski method wherein the single crystal is pulled under a hydrogen partial pressure by virtue of the use of argon in the pulling apparatus as a purging gas (cf. col. 1, l. 13-22), considering that argon, even in its purest form contains about 1 part per million of hydrogen, and thus has a partial hydrogen pressure of less than 3mbar.

Holder et al do not necessarily teach the further limitations that (a) the silicon single crystal is doped with nitrogen to a concentration of $5x10^{12}$ to $5x10^{15}$ atoms/cm^3, nor that: (b) the silicon semiconductor wafer is separated from the silicon single crystal.

However, it would have been obvious to include further limitation ad (a) in view of Ikari et al, who teach in an invention on the production of a semiconductor wafer using the Czochralski method that nitrogen doping with a concentration between 10^{16} and 10^{19} atoms/cm^3 may be used advantageously to achieve higher purity in the single silicon crystal, in particular to achieve a lower defect density (cf. col. 9, l. 22-30). Motivation to include the teaching by Ikari et al in the invention by Holder et al derives from the common purpose of Holder et al and Ikari et al to produce a purer silicon single crystal by reducing oxygen-related

impurities within the single crystal. The teaching may be easily combined with the invention through adding nitrogen as recommended by Ikari et al to the argon gas as used by Holder et al (cf. Holder et al, col. 1, l. 13-22).

Finally, it would have been obvious to include the further limitation ad (b), i.e., to separate the wafer from the single silicon crystal, because the single silicon crystal is most economically made so as to produce a multitude of single crystal silicon substrates in wafer form: the silicon single crystal as depicted in Figure 1 in Holder et al is not in wafer form and thus must necessarily be sliced to produce wafers, as shown by Tamatsuka et al (cf. abstract). Motivation to include the teaching by Tamatsuka et al in this regard is the possibility to produce many wafers from one single crystal ingot, while the slicing automatically produces the shape needed in the semiconductor industry.

8. ***Claim 6*** is rejected under 35 U.S.C. 103(a) as being unpatentable over Ikari et al and Yamamoto et al, or, in the alternative, over Holder et al, Ikari et al and Tamatsuka et al as applied to claim 2 above, and further in view of *Kono et al* (JP408032038A).

As detailed above, claim 2 is unpatentable over Ikari et al in view of Yamamoto et al, and also over Holder et al in view of Ikari et al and Tamatsuka et al, none of the above references necessarily teaching the further limitation of claim 6. However, subjecting a single crystal silicon semiconductor wafer to an oxidation treatment is a well-known method for the production of an SOI substrate, as witnessed by Kono et al (cf. English abstract, "Constitution"). The further limitation of claim 6 is thus rendered

obvious as an obvious use of the product made, motivation to include the teaching by Kono et al stemming from the capitalization of a well-known application of the product made.

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure: Japanese Patent Application JP-2000-026196 (Ikari et al).

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P Mondt whose telephone number is 703-306-0531. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J Flynn can be reached on 703-308-6601. The fax phone number for the organization where this application or proceeding is assigned is 703-308-7722.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

JPM
November 10, 2003